8. Lowering Device Power Supply Unit
    a. Use a lowering device power supply unit that is either an electric drill motor or a NEMA frame motor.
        1) Equip both motors with a factory-set torque limiter. Power each from a weatherproof outlet or receptacle located in the service area of the pole.
        2) You may use a stepdown transformer to supply the required motor voltage.
    b. Make the transformer an integral part of the power supply unit, when required.
    c. Attach and lock in place the drill or motor at the pole handhole. Provide a remote control system that works from at least 20 ft (6 m) away.
9. High Mast Power Cable
    a. Use extra-heavy duty power cable in a jacket that resists oil and sunlight. Include in the cable the number and size of copper insulated conductors required on the Plans.
    b. Securely connect the power cable to the luminaire mounting ring and the suspension cable bracket assembly so it will not damage the cable and supports only its own weight.
10. Pole Disconnect
    a. Furnish each pole with a molded case circuit breaker in a NEMA enclosure of the size and type specified on the Plans.
    b. Make the breaker accessible through the pole handhole. Get the breaker from the manufacturer of the raising and lowering device.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Submit guarantees on materials and equipment.

920.2.06 Grounding

A. Requirements

General Provisions 101 through 150.

B. Fabrication

1. Connect the power system ground to the pole.
2. Include a grounding conductor with the high mast power cable and connect it to the luminaire mounting ring.
3. Ground the pole disconnect to the pole.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

Section 921—Luminaires

921.1 General Description

This section includes the requirements for the following types of luminaires:

- Roadway
- Rest area
- High mounting height
- Offset
- Underpass
- Navigation lighting

921.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

ANSI/IES Types (specified on Plans)

921.2 Materials

Use luminaires that are complete, including ballast, lamps, fuses, and associated hardware and wiring.

921.2.01 Luminaires

A. Requirements

1. Standard Equipment for Roadway, Rest Area, High Mounting Height, and Offset Luminaires

   Use luminaires for these locations that have the following equipment:

   a. Lamps: Check the Plans for the lamp wattage, type, and size.

   b. Ballasts: Use ballasts that meet these requirements, unless otherwise specified:

   - Are part of the luminaire housing or in a separate weatherproof housing attached to the luminaire housing.
   - Are used for multiple circuits, unless otherwise specified.
   - Operate at voltages shown on the Plans.
   - Provide rated lamp watts to the lamp through a range in primary voltage of +10 percent.
   - Have a power factor of at least 0.90.
   - Provide enough open circuit voltage to start lamps at a temperature as low as–20 °F (-29 °C).
   - Are enclosed in an epoxy encapsulated covering (mounted on the external pole base or cabinet).

   c. Controls: The local power company will provide and install control equipment, including photoelectric control, receptacle, contactor, and other equipment, unless otherwise indicated on the Plans.

   d. Level Indicator: When shown on the Plans as a required item, ensure that each luminaire has a built-in device indicating the direction and amount of tilt over a range of 0 to 5 degrees in any direction. Ensure that the indicator has the following characteristics:

   - Has three calibrations, accurate to within 1/2 degree:

A	Level
B	3 degree tilt
C	5 degree tilt

   - Is clearly visible without aid in daylight to a distance of 50 ft (15 m).
   - Does not alter or reduce the amount of light from the luminaire.
   - Has a transparent container made of clear, ultraviolet-inhibited acrylic. The lower surface is curvilinear in any vertical cross-section to support a spherical indicator and dampening fluid.
   - Uses a clear dampening fluid made of 70 percent glycerol and 30 percent iron-free water.
   - Uses a highly visible orange or red color ball in the spherical indicator that is chemically inert to the dampening fluid.

2. Roadway Luminaires

   Ensure that roadway luminaires have or meet the following requirements:

   a. Are placed horizontal or vertical as indicated on the Plans.

   b. Have an aluminum housing with the following:

   - A 2 in (50 mm) slipfitter
   - A removable aluminum reflector
   - A detachable prismatic glass refractor and aluminum refractor holder
   - A prewired terminal board and integral ballast

- An adjustable, porcelain enclosed mogul socket with spring loaded center contact and lamp grips
- An approved type gasket with a positive latch at the street side of the luminaire

c. Distribute light according to ANSI/IES type as specified on the Plans.

3. Rest Area Luminaires

Ensure that rest area luminaires have or meet the following requirements:

- Are placed vertically
- Have a hinged aluminum canopy
- Have a pressed glass prismatic refractor, unless otherwise specified
- Have a die cast aluminum base/housing with access door and slipfitter for a 3 in (75 mm) OD pile top or tenon
- Have a prewired terminal board and integral ballast
- Have a porcelain enclosed mogul socket with spring loaded center contact and lamp grips
- Distribute light according to ANSI/IES type as specified on the Plans

4. High Mounting Height Luminaires

Ensure that high mounting height luminaires have or meet the following requirements:

a. Have a rain-tight, precision-cast, aluminum housing that includes an adjustable slipfitter for a 2 in (50 mm) mast arm that allows adjustments of at least 3 degrees above and below the mast arm axis.

b. Contain a prewired terminal board.

c. Have an integral ballast with quick disconnect plug.

d. Have an adjustable porcelain-enclosed mogul socket with spring-loaded center contact and lamp grips.

1) Ensure that the lamp socket adjusts to obtain maximum intensity at vertical angles from 55 to 65 degrees.

2) Provide a separate lamp support to prevent vibration damage.

e. Be able to accept No. 6 to No. 14 AWG wire with clamp-type terminals.

f. Have ballast enclosed in a rain-tight cast aluminum housing, fully serviceable without removing the luminaire from its bracket.

g. Have refractors and/or lens that are heat- and shock-resistant tempered glass.

h. Distribute light according to ANSI/IES type as specified on the Plans.

5. Offset Luminaires

Ensure that offset luminaires have or meet the following requirements:

a. Have rain-tight, precision-cast aluminum housing with a baked-on enamel finish and the following:

- Twin trigger latches
- A hinged door for easy access to internal components
- Non-corrosive hardware

b. Include a porcelain-enclosed mogul socket with spring-loaded center contact and lamp grips.

1) Ensure that the grips are permanently attached to the reflector to properly position the lamp.

2) Equip the socket wiring with a quick-disconnect to easily remove the reflector/socket assembly.

c. Include a highly polished, anodic-surfaced, aluminum reflector and a prismatic borosilicate glass refractor.

d. Have seals or gaskets at all critical points to form a weather-tight breathing seal.

e. Include a prewired terminal board.

f. Have integral wired ballast (that meets the ballast requirements of this Specification and the Plans).

g. Have a slipfitter for a 2-3/8 to 3 in (60 to 75 mm) OD pole tenon and external means to level and aim, both horizontally and vertically, for rapid and versatile field installation.

h. Be adjusted and sized, after the pole is erected and plumbed, to provide the lighting pattern according to the Plans and the manufacturer's recommendations and instructions.

i. Efficiently distribute light uniformly along the roadway when offset as shown on the Plans and with spacings up to 7 mounting heights.

6. Underpass Luminaires (Type A)
   a. Housing: Ensure that the Type A housing meets these requirements, unless otherwise indicated on the Plans:
      - Be surface-mounted at about 15 ft (4.5 m) above the edge of the finished pavement on an outside bridge pier, as shown on the Plans
      - Be die-cast aluminum with an integral ballast
      - Have a specular aluminum reflector
      - Have a detachable thermal shock-resistant glass refractor
      - Have an adjustable porcelain-enclosed mogul socket with spring-loaded center contact and lamp grips to properly position the lamp
      - Have a hinged door assembly protected by safety chains and an approved gasket to keep out moisture and dirt
      - Be able to attach directly to the bridge pier or underpass wall
   b. Light Distribution: For Type A, use an enclosed High Intensity Discharge (H.I.D.) luminaire, unless otherwise indicated on the Plans.

      Ensure that the luminaire distributes light in a wide-beam, diffused pattern.
   c. Lamp: Use a lamp of the wattage, type, and size shown on the Plans.
   d. Ballast: Use ballast that meets the provisions of Subsection 921.2.01.A.1.b.
   e. Controls: Use controls that meet the provisions of Subsection 921.2.01.A.1.c.
   f. Include all thimbles, fittings, elbows, etc., in the price bid for conduit. The Department will include a pay item for necessary conduit in the contract.
7. Underpass Luminaires (Type B)
   a. Housing: Ensure that Type B housing meets the following requirements:
      - Be made from aluminum with a specular-finish, one-piece aluminum reflector and a clear, ribbed, one-piece detachable, side-hinged cover of acrylic plastic. Ensure that the cover is completely gasketed to keep out contamination.
      - Have a heavy-duty, galvanized mounting support that allows the unit to rotate 180 degrees around its lateral axis when mounted.
      - Include spring-loaded, heavy-duty, recessed, double-contact lamp holders to accept a single F-72/PG 17 fluorescent lamp.
      - Be able to attach to the bridge pier or underpass wall.
   b. Light Distribution: For Type B, use an enclosed fluorescent luminaire with a wide-beam, diffused light distribution pattern.
   c. Lamp: Use a 165 watt F-72 PG 17/CW fluorescent lamp with a recessed double contact base and a rated life of at least 12,000 hours, unless otherwise indicated on the Plans.
   d. Ballasts for Multiple Circuits: Use ballasts that meet the following requirements:
      - Have a power factor of at least 0.90 to operate at voltages shown in the Plans
      - Provide enough open-circuit voltage to start lamps at temperatures as low as –20 °F (-29 °C)
      - Are inside the luminaire housing
      - Can service one or two luminaires as indicated on the Plans
   e. Controls: Use controls that meet the provisions of Subsection 921.2.01.A.1.c.
   f. Circuit Breakers: Install galvanized, weatherproof circuit breakers and cabinets as indicated on the Plans. Use cabinets 12 x 10 in (300 x 250 mm) deep.
   g. Install cabinets, conduit, and complete wiring as shown on Plans and as directed by the Engineer.
8. Navigation Lighting Luminaires
   a. Housing: Use cast aluminum housing of the type specified on the Plans. Use housing that has a gasketed service door for relamping.
   b. Lamps: Use clear, 100-watt, rough service lamps with 125-130 volt rating.
   c. Receptacles: Use receptacles rated at least 660 watts, 250 volts for medium screw base lamps.

      Use a design that will not freeze the lamps with aluminum screw base shells.
   d. Lens: Use 8 in (200 mm) marine type, fresnel lens(es).

1) Use a lens color with horizontal arcs of visibility as shown on the Plans.
2) For fixed span installations, you may use a combination of the following luminaires and colors:

Location	Color	Degrees of Horizontal Arcs of Visibility
Channel center	Green	360
Channel margin	Red	180
Main channel	White	180
Pier, bent	Red	180
Abutment	Red	180
Fender system	Red	180
Axis line or center line	Red	180

3) Mount channel marker luminaires with a swivel so that you can move the arm and luminaire in a 180-degree arc to replace the lamp and maintain the unit.
4) Unless otherwise noted, use pivot or swivel-type channel marker luminaires with either bronze or galvanized steel retriever chain and swivel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

Section 922—Electrical Wire and Cable

922.1 General Description

This section includes the requirements for electrical conductors, wire, and cable.

922.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

National Electrical Code

922.2 Materials

922.2.01 Electrical Wire and Cable

A. Requirements

1. Conductors

   Unless otherwise specified, use conductors that meet the following requirements:

   - Are made of copper
   - Are the size and type shown on the Plans
   - Meet the requirements of the National Electrical Code
   - Have the appropriate identification on the outer jacket.

NOTE: Do not use conductors not meeting this requirement or with illegible identification.